Rev. B
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On-site Waste Disposal Facility
Landfill Wastewater Management Strategy

The On-site Waste Disposal Facility (OSWDF) Preliminary Design is predicated on a number of conservative assumptions regarding the generation, collection, storage, and treatment of contact water and leachate. The design requirements were established to meet the project's ARARs, but in addition, strong emphasis was placed on lessons learned in the management of contact water and leachate at the Environmental Management Waste Management Facility.

It should be noted the analyses and results described below are based on analysis and calculations prepared in support of the 60% preliminary design package and are for the fully developed landfill with four disposal cells.

Leachate and Contact Water (L&CW) Generation

The design basis for generation of contact water is the 100-yr, 24- hour rainfall event. Three landfill development scenarios were evaluated in the Contact Water Flow Hydrology Calculation. The worst case scenario that produced the largest volume of contact water was used for the input to design of transport and storage equipment. The contact water is drained by gravity-flow pipes from the disposal cells into the L&CW Collection Pond. Leachate is pumped from the disposal cells in to the pond.

The design basis for leachate generation considered two methods of analysis. The first analysis provides estimates for leachate generation during the analyzed precipitation events using the Hydrologic Evaluation of Landfill Performance (HELP) Model. The HELP outputs were based on the 100-year synthetically created precipitation record for Knoxville (the nearest city in the HELP database) coupled with the soil layer data and geometry of the landfill disposal cells.

In the second analysis the 2003 precipitation data from the historical data at the Y-12 meteorological station was introduced in the data through manual input. This results in two simulations, one for the 100-yr storm and one for the 2003 historical rainfall record. The results of these two simulations indicated that peak leachate flows should be based on the 100-yr, 24-hr storm event, but average annual flow should be based on the 2003 historical record simulation. Average and peak leachate flows, for the purposes of downstream equipment sizing, were based on the landfill development scenarios that yielded the highest average or peak leachate flow rates.

The leachate is removed from each cell using a side-slope riser system and submersible pumps. Each cell has a staged pumping system using two low-flow pumps and a single high flow pump. The flow ranges vary slightly from cell to cell, but typically are in the range of 10 GPM to 115 GPM. Due to phased development and filling of the disposal cells, not all cells can contribute the maximum flow to the L&CW Collection Pond. Although a much smaller contribution that CW, the leachate volume is given an allowance of 0.75 MG in the pond sizing.

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The pond acts as the intermediate storage point for both contact water and leachate. Design metrics for contact water collection are noted below:

- Gravity flow pipes carry the peak flow from 100-year storm with no ponding in disposal cells.
- The peak CW inflow to the pond is 119 cfs total from all cells
- The cumulative volume received from the 100-year storm is 2.08 MG
- The max pumping rate from the L&CW pond to storage is 1,100 gpm which requires a working storage volume of 1.25 MG in the L&CW Collection Pond.
- The pond was designed for 2.0 MG capacity to allow for the smaller volume contribution from the Leachate Collection System.
- The pond has 2-ft of freeboard that adds an additional ~ 0.75 MG capacity before the pond would overtop. Maximum capacity at overflow is 2.75 MG.

Landfill Wastewater Storage

The Preliminary Design includes a large tank farm to provide ample storage capacity for combined contact water and leachate (i.e., landfill wastewater) that is pumped through a force main from the L&CW Collection Pond to the tank farm. This storage, in combination with the L&CW Collection Pond, is designed to provide capacity to hold volumes of wastewater from large storm events and provide sufficient capacity that the wastewater can be sampled in batches to determine if a tank's contents are able to meet the discharge limits without treatment. The tank farm included six 500,000 gal welded steel tanks with a pre-designed footprint to allow two additional 500,000 gal tanks that could bring the ultimate storage capacity to 4 MG.

The Jacobs design team performed a risk analysis, documented in Technical Memorandum (TMEM) – 016, that looked at the routing of landfill wastewater through either six or eight storage tanks with consideration that sample results turn-around-time could be as long as seven days. This analysis also conservatively assumed the working capacity of the tanks as 490,000 gal. Daily rainfall amounts from the 2003 historic wet year were used as inputs to the storage model. The storage and treatment capacity evaluation analyzed seven different scenarios (Scenarios 8– 14) to demonstrate the range of options available during each landfill filling stage. Tank storage capacity (3 MG or 4 MG storage), LWTS Treatment capacity (60 gpm or 30 gpm), and treatment conditions (treat all, treat 50%/discharge 50%) were variables used to develop the scenarios. All scenarios utilize the 2.75 MG capacity available in the L&CW Collection Pond with transfer to the tanks at 1,100 gpm.

A summary of the capacity analysis scenarios are shown below in Table 5.

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Table 5. Water Storage and Treatment Scenarios

Scenario	Fill Stage	Storage Capacity*	Treatment Pump (gpm)	Water Treatment
8	1	3 MG (six 0.5-MG Tanks)	60	Treat all wastewater in LWTS
9	1	3 MG (six 0.5-MG Tanks)	30	Treat approx. 50% of wastewater in LWTS; discharge after analysis 50% of wastewater
10	3	3 MG (six 0.5-MG Tanks)	60	Treat all wastewater in LWTS
11	3	3 MG (six 0.5-MG Tanks)	30	Treat approx. 50% of wastewater in LWTS; discharge after analysis 50% of wastewater
12	3	3 MG (six 0.5-MG Tanks)	60	Treat all wastewater in LWTS with no 7-day testing
13	3	4 MG (eight 0.5-MG Tanks)	60	Treat all wastewater in LWTS
14	3	4 MG (eight 0.5-MG Tanks)	60	Treat all wastewater in LWTS with no 7-day testing

*All storages capacity also includes an additional 2.75 million gallons of storage in the Cell 4 pond

For each of the scenarios described in Table 5, a day-by-day storage and treatment analysis was performed using the peak year (2003) daily rainfal he daily contact water and leachate volumes were used to calculate the amount of wastewater generated in each day of the peak year. A spreadsheet was used to model the tanks and track the amount of wastewater stored in each based on the daily wastewater generation for each scenario. The summary of this analysis is presented in Table 6.

Table 6. Water Storage and Treatment Scenario Results

Scenario	Fill Stage	Model Scenarios Storage/Wastewater Treatment	Annual Wastewater in Gallons			Max Stored in Pond (Up to 2.75MG)	Longest Time to Empty Full Tank*	Days Pump Does Not Run
			Treated in LWTS	Discharged after Analysis	Byapss Overflow to Stream			
8	1	3 MG/all WW treated; 60 gpm treatment	25,988,916	-	-	1,578,814	25	39
9	1	3 MG/~50% WW treated; 30 gpm treatment	13,500,000	13,050,000	-	1,682,642	34	31
10	3	3 MG/all WW treated; 60 gpm treatment	31,294,569	-	1,367,634	**2,750,000**	28	0
11	3	3 MG/~50% WW treated; 30 gpm treatment	15,750,000	15,750,000	-	2,444,595	40	6
12	3	3 MG/all WW treated, 0 testing; 60 gpm treatment	31,120,205	-	300,498	**2,750,000**	25	0
13	3	4 MG/all WW treated; 60 gpm treatment	30,094,847	-	126,133	**2,750,000**	39	0
14	3	4 MG/all WW treated, 0 testing; 60 gpm treatment	31,420,703	-	-	2,510,065	35	7

*Longest time frame that a tank reaches max capacity and it is in either testing or waiting to be treated

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The results for scenario 10 indicate that ~ 1.37 MG of wastewater would need to be bypassed without treatment to avoid overtopping the L&CW Collection Pond. It should be noted in this scenario none of the collected wastewater is released to the treatment system during the 7-day hold period for samples. In scenario 12 only ~ 0.3 MG is bypassed when no wastewater is held for the 7-day period. It requires addition of two storage tanks (max capacity of 4 MG) to eliminate the risk of a bypass as indicated in scenario 14.

These results indicate, in the most vulnerable landfill development stage and if a historically wet year such as 2003 occurred, there is possibility 0.3 MG out of a total wastewater input of 31.4 MG could be released without treatment if only six storage tanks are used. Adding two more tanks and treating all wastewater with no sample hold time eliminates this risk. Also, more uniform distribution of the rainfall across the year will reduce the risk.

Leachate and Contact Water Quality Estimates

To prepare a design basis for the Landfill Wastewater Treatment System (LWTS), the design team needed to estimate the water quality of both the leachate and contact water for comparison with known water quality standards to evaluate what type of water treatment may be needed. TMEM-008 contains Table 1, which shows the water quality estimates for leachate and contact water for many contaminants.

The leachate and contact water values for mercury are provided in Table 1 (see excerpt below). They were estimated using the soil-water partition relationship for potential COCs based on the sorptive properties of the geologic matrix. The bases of the estimate are calculated leaching factors and the expected waste profile at OSWDF developed from data collected from EMWM he data from the EMWMF were determined to be applicable to the proposed OSWDF site because of the similarity between the facility locations, precipitation patterns and liner design, and waste source, handling, and processing at the two locations.

Mercury	Expected OSWDF LF Contact Water Quality		Expected OSWDF LF Leachate Water Quality	
	Avg (µg/L)	Max (µg/L)	Avg (µg/L)	Max (µg/L)
	0.35	0.85	0.31	0.76

These estimated influent concentrations for mercury in contact water and leachate were used in the mass balance for the LWTS that predicted the percent reduction in the mercury concentrations that could be achieved in the wastewater treatment processes.

Landfill Wastewater Treatment System

The strategy for landfill wastewater treatment envisions two 30-gpm treatment trains to provide flexibility in implementation based on observed water quality conditions after startup. Staged construction of the treatment trains is anticipated and facilitated by the 3 million gallons of storage

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capacity that is provided by the 6 tanks within the tank farm (with an additional 1 million gallons of storage available in the future if needed).

The treatment technologies included in the OSWDF Preliminary Design include chemical precipitation of metals (including mercury), granular activated carbon adsorption of organics and residual mercury, and ion exchange of radionuclides. The unit operations selected lend themselves to modular design and support dividing each train into sub-trains: Trains 1A and 2A provide metals removal, and Trains 1B and 2B target strontium-90, organic COCs, and mercury polishing. Because the quantity and quality of landfill wastewater are projected, the LWTS will be implemented in stepwise fashion to respond to actual conditions, beginning with the construction of Train 1A to provide metals removal with a 30-gpm capacity. If wastewater flows routinely exceed 30 gpm and contain the anticipated metals, the Train 2A equipment will be added to the LWTS to increase treatment capacity to 60 gpm. If strontium-90 or the organic COCs are present, the Train 1B and 2B equipment will be added to the LWTS. The unit operations covered in the Preliminary Design are listed below:

Train 1A of the OSWDF LWTS consists of the following major process components for metals removal:

- Equalization tank with sulfuric acid and sodium hydroxide addition for pH adjustment to optimize the removal of hexavalent chromium, mercury and other dissolved metals
- Sulfide-functional reaction tank with sulfide-functional polymer addition system to target the removal of mercury from the landfill wastewater entering this process
- Co-precipitation reaction tank with ferrous sulfate addition system to convert the hexavalent chromium to trivalent chromium, which is coagulated during the conversion of ferrous sulfate to ferric sulfate, while functioning as a coagulant for the removal of other suspended solids
- Flocculation tank with coagulant addition system with sulfuric acid and sodium hydroxide addition for pH adjustment as needed to optimize the coagulation process
- Inclined plate clarifier/thickener to efficiently separate the coagulated solids, allowing for their removal from the process for consolidation, thickening, and pressing of these solids for disposal
- Microfiltration system with feed tank and pumps, backwash storage and backwashing equipment, and clean-in-place (CIP) system
- Sludge thickening and dewatering system with sludge settling tanks, filter press feed pumps, thickening aid polymer system, and filter press

Should additional treatment be required, the following processes have been identified for implementation in Train 1B:

- Ion exchange system for strontium-90 with brine storage and backwash tanks and pumps for ion exchange media regeneration; brine precipitation tanks with lime, soda ash, and thickening aid polymer addition systems to treat the brine waste before return to the equalization tank
- Granular activated carbon, with backwash tank and pumps, to remove organic COCs and residual levels of mercury

Train 2A and 2B would duplicate most of the equipment described above to increase the total treatment capacity to 60 gpm. Due to the relatively low flow rates, trains 1 and 2 can share some process equipment (e.g., solids processing equipment) to avoid unnecessary duplication.

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Wastewater Treatment Mass Balance

The Preliminary Design included a mass balance calculation that forecasts the concentration of all contaminants as reductions are achieved in various treatment processes. In the case of mercury, using an average influent concentration of 0.330 µg/L, the predicted effluent concentrations of 0.003 µg/L for train 1A and 0.0003 µg/L for train 1B correlates to 99.1 and 99.9 percent efficiency for removal of mercury. Note the assumed effluent limit for mercury, based on recreational water quality criteria is 0.051 µg/L. The predicted effluent concentration are 17 to 170 time lower based on the effectiveness of the treatment options used.

Summary of Design Basis Conservatism

The design basis for the OSWDF uses requirements from the ARARs such as the 100-yr, 24- hour storm for peak runoff flows but also considers operational lessons learned from nearly 20 year's operation of the EMWMF. That experience has demonstrated that other rainfall conditions may produce a more challenging scenario for managing contact water and leachate than any 1-day rainfall event. Summarized below are the key assumptions and design bases that provide for an extra measure of conservatism in the design of OSWDF water collection, storage, and treatment systems.

- Contact water collection, storage, and transfer system components are sized based on the 100-yr, 24- hour storm to ensure containment of largest single storm event.
- Leachate transfer systems (i.e., pumps and pipelines) sized for peak flow rates using the 100-yr synthetic rainfall input from the HELP model and storage volume requirements sized using the daily volume inputs from the 2003 historic wettest year at the Y-12 meteorological station.
- There is no temporary containment of contact water in a disposal cell until the final sequences of filling in cell 4 when the L&CW Collection Pond area must be modified to provide the cell 4 leachate collection sump.
- All leachate and CW will be collected and provided intermediate storage in the L&CW Collection Pond. Design attributes of the pond include,
    - Capacity to store the volume received from the 100-year storm (2.08 MG)
    - With maximum pumping rate of 1,100 gpm to the storage tanks, a storage volume of 1.25 MG in the L&CW Collection Pond is needed for CW only.
    - The pond was designed for 2.0 MG capacity to allow for the lesser volume contribution from the Leachate Collection System.
    - The pond has 2-ft of freeboard that adds an additional ~ 0.75 MG capacity before the pond would overtop. Maximum capacity at overflow is 2.75 MG.
- The design provides a leachate tank farm with six 500,000 gal storage tanks in the Phase 1 design and space allocations to add two additional tanks. Flow modeling of the storage requirements using the 2003 historic wettest year daily wastewater volumes indicated some operational scenarios where a small fraction of the overall influent wastewater would require by-pass of the treatment system. Eliminating the 7-day hold time for batch sampling of tanks

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and/or adding the seventh and eighth storage tanks, will eliminate the risk of by-pass under this very demanding total rainfall scenario.

- The LWTS process design uses conventional and well-proven treatment technologies that can be deployed in modular fashion to increase the base processing rate from 30 gpm to 60 gpm and to add treatment units to provide for removal of contaminates that may not be initially present in the wastewater.
- Mercury is calculated to be removed in the train 1A basic treatment process (i.e., chemical precipitation) at an efficiency of 99.1% and further reduction of mercury levels will be accomplished in the train 1B treatment using granular activated carbon columns. This "polishing" step provides for an overall mercury treatment efficiency of 99.9%.
- Based on the anticipated mercury influent concentration of 0.330 µg/L and an assumed discharge limit of 0.051 µg/L, these treatment efficiencies equate to a discharge concentration that is 17-170 times lower than the discharge limit.

The OSWDF approach for management of leachate and contact water is conservative and results in installation of robust and reliable systems for collection, transfer, storage, and treatment of these wastewater sources. The deign basis and analysis are always predicated on worst case scenarios such as the 100-yr storm event, 2003 wettest year historical data, and a landfill filling sequence that produces maximum volumes of contact water and leachate. It is unlikely that all of these "worst case" scenarios will overlap. Further, historical data and lessons learned from EMWMF had influenced many design decisions that provide an improved and more reliable design.